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TOWARDS AN EFFICIENT AND SUSTAINABLE TARIFF METHODOLOGY FOR THE EUROPEAN GAS TRANSMISSION NETWORK

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Executive summary

Gas transmission in Europe is currently based on the so-called entry-exit model. Under such a model, Europe is divided into gas balancing zones – also called entry-exit systems – and capacity is charged at both entry and exit points of every balancing zone. Current entry-exit systems largely coincide with Member States' territory. The cost of gas transmission networks in Europe is thus covered via the so-called entry-exit tariffs.

The shift to the entry-exit model was one of the most effective measures included in the Third Energy Package (2007), which facilitated smooth transition from the traditional system, based on vertically integrated European gas industry structures to a single liberalised European market. However, as the EU gas market develops, the current tariff methodology is now being questioned, on the grounds that it may be unsuitable to achieve the objective of a single pan-European market, with unbiased gas flows and no obstacles to trading.

This paper analyses alternative tariff methodologies that would address the drawbacks of the current system.

The first approach meets the transmission revenue requirement by charging only the transmission network's exit points to distribution networks and to directly connected end-customers.

The second approach does not charge entry and exit intra-EU boundaries, and offsets the missed revenues via charges at the points of entry of foreign gas supply into the EU transmission system.

Further, we investigate data on physical gas flows, commercial transactions between EU countries and non-EU suppliers and capacity bookings, from multiple sources.

Our analysis suggests that:

i) current gas flow patterns in Europe are different from those that minimize intra-EU shipping cost evaluated at the current transmission tariffs; we conjecture that this feature is related to the existing stock of long-term capacity holdings;

ii) in case the optimal flow pattern was implemented, a material reduction of overall tariff revenues would occur, other things being equal; further*,* the revenue shortfall would be unevenly split among routes and system operators;

iii) the cost of shipping gas to a European country from different points of entry into the European network is materially different, to the point that one cannot rule out the possibility that the current tariff model has an impact on the selection of the upstream suppliers.

Introduction

The cost of gas transmission networks in Europe is currently covered via the so-called entry-exit tariffs. This tariff methodology is based on charging capacity reservations at both entry and exit points of balancing zones, or entry-exit systems. Current entry-exit systems largely coincide with Member States' territory.

The entry-exit model has the important merit of having supported a smooth transition from the traditional organization of the European gas industry, based on separate national markets and monopoly supply, to a single liberalized European market, where gas is continuously exchanged across the borders by a large number of market players.

However, as the EU gas market develops, the current tariff methodology has been questioned, on the grounds that it may be unsuitable to achieve the objective of a single pan-European market, with unbiased gas flows and no obstacles to trading[1]. In particular, the entry exit-model may:

[1] EY and REKK, 2018, *Quo vadis EU gas market regulatory framework – Study on a Gas Market Design for Europe (Chapter 3) and* Energia, Giugno 2017, pp. 64-65. Il dibattito sulla riforma dei corrispettivi di trasporto del gas (contributions by Federico Boschi and Hannelore Rocchio.

- distort the selection of gas sources.
- prevent desirable pooling of sources of flexibility available in different Countries.
- be unsuitable to ensure network cost recovery in a context of uncertain gas demand and/or when excess import capacity needs to be maintained for security of supply.
- result in an unwanted wealth transfers between consumers located in different Countries.

This paper analyses two possible alternatives to the current transmission tariff methodology, that would address some of its drawbacks. The first one covers the entire transmission revenue requirement by charging the network's exit points towards distribution networks and directly connected end-customer premises. The second one sets the entry and exit charges between intra-EU bidding zone to zero, offsetting the missed revenues via charges at the entry points at the borders of the whole EU transmission system.

In contrast to the current system, the alternative models may require an explicit mechanism to share the cost of transit networks among consumers connected in different countries. We consider two possible designs for such mechanisms. The first one assesses the share of transit networks' cost falling on destination countries according to a methodology that replicates the outcome of the current arrangements. The second design option allocates ex-ante a share of the overall revenue requirement to each European country. In this approach, the share of transit networks cost falling on destination countries does not depend on the tariffs and realised demand for that networks' services. This approach would address also a broader potential weakness of the current regulatory framework, namely its lack of sustainability in case the trend of declining gas demand does not reverse, and/or if covering most of the cost of (desirable) network upgrades cannot be met by selling long-term transmission rights.

Finally, in order to assess the potential scope of the distortions caused by the current transmission charging methodology and the impact of the alternative methodologies, we investigate data on physical gas flows, commercial transactions between EU countries and non-EU suppliers and capacity bookings, from multiple sources, including the ENTSOG Transparency Platform, Eurostat and the European Transmission System Operators' websites.

The paper is divided into four sections. In the first section, we discuss the transmission tariff methodology currently implemented in the European gas sector. In the second section, we present alternative methodologies addressing the drawbacks of the current system. In the third section, we investigate empirically the scope of the distortions that may be caused by the current transmission charging methodology and the impact of the alternative schemes. The fourth section contains concluding remarks.

1. The current gas transmission tariff methodology in Europe

The main features of the current European gas transmission tariff methodology include:

- network users pay for the right to move gas across the borders of neighbouring gas systems (balancing zones or entry-exit zones). The tariff is assessed based on the transmission capacity reservations and, in some systems, on the gas volumes moved across the interconnection[2];
- the entry-exit zones largely reflect the political geography of Europe;
- the tariff level for each entry or exit point is set by the national regulator of the country in which the point is located, according to a methodology that splits the total cost of the zone's transmission network among all its entry and exit points.

We discuss next the main potential drawbacks of the current transmission tariff design.

Distortion of gas market results

[2] We do not consider here the variable components of transmission tariffs that (correctly) reflect variable costs, such as gas compression cost.

Multiple paths across different entry-exit zones are available in Europe to move gas between two systems. As a consequence of different transmission costs of shipping gas to a certain country along routes crossing different entry-exit zones, the merit order of natural gas sources for the destination country may be distorted, potentially resulting in imports from systems where gas is more expensive.

The dependence of transmission tariffs from the path connecting the point of entry into the EU system and the final destination may be regarded as reflecting a fairness principle, possibly related to a long-term cost-causation criterion. The underlying idea would be that a country's transmission system used to transit gas should be at least partially paid for by those who benefit from it, i.e. the consumers in the destination country. However, achieving this fairness objective via tariff pancaking may discourage the movement of gas within Europe. This outcome is inefficient, given that tariffs do not reflect variable costs of using the infrastructure. In this respect, the entry-exit model is inadequate to achieve the single market objective[3].

The same feature of the European gas transmission methodology may inefficiently reduce cross-border provision of flexibility services. In particular, transmission fees make the cost of balancing a position in a country with domestic storage or with storage located in a neighboring country different. Such a cost gap does not reflect, as it should, the different variable cost of moving gas to and from the different storage sites. This holds all the more because of the intertemporal structure of current transmission tariffs, that in most countries penalizes short-term purchases of transmission services.

The fact that a sizable portion of the existing capacity was allocated to market participants under long term contracts mitigates the distortive impact of the tariff methodology on the gas market outcome that we observe now[4]. This happens because the holders of long-term capacity reservations pay transmission tariffs whether or not they use reserved capacity; as a consequence, their decisions to use or trade the capacity they have reserved is not affected by the level of transmission tariffs[5]. However, once the existing long-term capacity reservations expire, the price elasticity of demand for transmission services at each entry/exit point will increase and the full distortive potential of the current tariff methodology will be realized.

Sustainability of low-utilisation infrastructures contributing to security of supply

Cost recovery of infrastructures with low utilization rates, nevertheless contributing to security of supply or contestability of the European market, might become impossible with the current tariff methodology. This might happen for example if utilisation of a large pipeline – mostly used for transit – in a small entry-exit system fell. In this case, covering the pipeline's cost through entry and exit charges at its ends would be impossible and, under the current model, tariffs at other entry and exit points of the small system would have to be raised to reach the revenue target. In a small system, though, the tariff increases necessary to offset the missing revenues on transits may be unsustainable.

The existing stock of long-term capacity contracts mitigates the impact of the current tariff methodology on the possibility to cover infrastructure cost in the context of falling demand for transmission services. One can doubt, though, that capacity bookings largely in excess of actual transportation needs will persist.

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[3] Incidentally, until the introduction of the new Network code on tariff (Commission Regulation (EU) 2017/460), national regulators have enjoyed much freedom in spreading the cost of national networks across the tariffs charged at the various entry-exit points. As a result, assessing to what extent the resulting charges would reflect a genuine long-term cost-causation principle is not straightforward.

[4] Gas price differentials between market zones smaller than the corresponding transmission cost are not unusual.

[5] Furthermore, EU congestion management rules are designed to prevent the exercise of market power through capacity with-holding.

Unwanted wealth transfers

Differentiation of wholesale gas prices at different locations may generate unwanted wealth transfers. Consider for example a country in which the marginal gas – i.e. the gas that sets the wholesale price in the country – is carried through the path with the highest total transmission cost. Since the price of the marginal gas reflects its transportation cost, all other gas imports will enjoy a rent unrelated to cost[6].

Uncertainty

Poor predictability of the conditions triggering tariff changes, and of the content of such changes, translates into uncertainty on the value of transmission rights, all the more in the context of a more dynamic wholesale gas market. This reinforces the tendency to short-termism in gas trading decisions. This issue has been recognized by the recent Network code on capacity allocation mechanisms[7], which provides measures to address it, but only for newly built infrastructures.

Relationship among Member States

An attractive feature of the current entry-exit methodology is that it allows European politicians and regulators to avoid addressing issues of transmission cost-sharing among European countries explicitly. This happens because each country's wholesale gas price reflects the entry and exit tariffs born to bring gas into the country. In this way, a country's consumers pay a share of the cost of the transmission infrastructures located in other European countries that were used to deliver gas in the country.

This attractive feature of the current model comes at the price of an opaque cost-sharing among countries and of possible tensions among national regulators. Opacity of cost-sharing among countries results from the fact that gas flows determine the share of European transmission cost ultimately falling on each country's consumers.

Tensions between national regulators may arise because each State can affect the cost-sharing between its and the other country's consumers through the choice of the entry and exit tariff levels. A transit country, for example, might seek to transfer the cost of transmission investments mainly benefitting its citizens, for example by increasing the reliability of the national network, to another country's consumers, through an appropriate choice of entry and exit charges at the interconnectors. This is possible because, in the current framework, national regulators approve upgrades of national transmission networks independently and enjoy much freedom in spreading the cost of national transmission networks across the tariffs charged at the different entry and exit points[8].

2. Alternative gas transmission tariff methodologies for Europe

The tariff methodology currently implemented in the European gas transmission sector is such that mostly fixed costs are covered through charges on capacity reservations. Covering infrastructure's fixed cost with charges based on the demand for its services distorts its use and the resulting inefficiency is larger the bigger the price-elasticity of the demand is for transmission services[9].

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[6] Equal to the difference between total transmission charges on the marginal source and their own.

[7] Commission Regulation (EU) 2017/459.

[8] This feature of the model is addressed by the recent tariff Network code (Commission Regulation (EU) 2017/460), but, *prima facie*, not to its full extent.

[9] This is a standard result of mainstream economic theory; see for example, D. Bös, Pricing and Price Regulation, Volume 34, 1st Edition, An Economic Theory for Public Enterprises and Public Utilities, 1994, Elsevier Publisher.

Since multiple transmission paths from the European borders to each country exist, the current tariff model's distortions depend on the price elasticity of the shippers' demand for transmission services along each path. Such elasticity is obviously larger than the elasticity of demand expressed by final consumers. This provides the foundation for an alternative tariff model in which the revenue requirement is entirely met by charging capacity at the transmission network's exit points towards distribution networks or large end-consumer sites, since this is the least elastic available charging basis. We discuss this model in section 2.1.

A further alterative to the current methodology has received attention in the policy discussion[10]. Even in this approach, cross-border tariffs within the EU are set equal to zero, so as to eliminate the main cause of gas price differentiation between market zones[11]. The revenue deficit resulting from not charging intra-EU interconnection capacity is now offset by increasing charges at the points of entry into the EU system. We compare the two alternatives to the current tariff model in section 2.2.

2.1. Cost recovery through exit charges to distribution networks and large end-consumer sites

Under this scheme, which we refer to as model 1, entry into the EU transmission network, as well as entry from and exit to interconnecting transmission networks within the EU are not charged. Therefore, the entire cost of the EU gas transmission network is covered via charges on the transmission network's exit points towards distribution networks and large end-consumer sites.

If this tariff model is implemented, no distortions in the merit order of alternative gas sources to Europe occur, since the same transportation tariff is levied on gas entering a destination country, irrespective of where that gas was injected into the European transmission system.

Under plausible assumptions about the wholesale gas price-formation mechanism, European consumers as a whole are better off, since the increase in exit tariffs is more than offset by the reduction in wholesale gas prices, other things equal. This happens because the move to the alternative tariff scheme: *a)* rules out any distortions in the merit order of upstream suppliers, ensuring that the cheapest gas sources are selected; *b)* avoids that the wholesale price for gas reflects one or multiple oligopolistic mark-ups on transmission cost[12].

From an implementation perspective, since intra-EU cross-border transmission tariffs in this model are set to zero, they cannot be used to share the cost of a transit network among all those who benefit from it. For this reason, this model would require additional arrangements to split the cost of transit transmission infrastructures among the European gas consumers. We present two possible cost-sharing mechanism next.

A cost-sharing mechanism preserving the distributional features of the current system

The key distributional feature of the current tariff system is that part of the cost of a transit system is passed-on to consumers connected in destination countries, through the price for capacity reservations necessary to transfer gas towards the destination countries[13]. Each regulator's discretion in splitting the cost between domestic consumption and transit is constrained by the provisions of the Tariff network code[14].

Although this cost sharing mechanism does not operate in the alternative tariff model, broadly the same distributional effects can be obtained through arrangements along these lines:

[10] Quo Vadis EU gas market regulatory framework – Study on a Gas Market Design for Europe. Preliminary report. Unpublished draft.

[11] Absent genuine congestions.

[12] This happens, with the current tariff methodology, to the extent that the market for importing gas into Europe or the internal wholesale market are less than perfectly competitive.

[13] We discuss later how long-term capacity reservations may mitigate this property of the current tariff model.

[14] COMMISSION REGULATION (EU) 2017/460.

- the transit network's revenue requirement is provisionally split between the transit country's consumers and the consumers connected in destination countries, as it would happen in the current system, based on a forecast of the demand for capacity on the transit network
- each country's regulator implements the new tariff model, i.e. sets charges at the exit point of the transmission networks to the distribution networks and large consumers' premises, in order to meet each country's revenue requirement, inclusive the allocated share of the transit network cost[15];
- compensation among the countries' system operators is then arranged, based on actual demand for the transit network's services, in order to obtain the same outcome as the one that would result from the current tariff model;
- in the following tariff-setting round, any gaps between the system operators' allowed and actual revenues[16], due to errors in the initial forecast of demand for transit services, are offset.

The need for arrangements like those just sketched stems from the fact that, in the current model, the allocation of a transit network's cost is determined only after the demand for its capacity materializes. On the contrary, in the alternative model, the revenue requirement for each system has to be set ex-ante, for the national regulator to set transmission tariffs consistent with it.

A cost-sharing mechanism with fixed shares

Under the current model:

- if demand in destination countries – and therefore demand for transit capacity – falls, consumers connected in the transit country might end up paying a greater share of the transit network's cost. This might be challenged as unfair, on the basis that investment took place based on different assumptions on transit and domestic use;
- if the current reluctance of market participants to take long-term transmission commitments endures, a large share of network upgrade cost will be allocated directly to consumers connected in the benefitting countries via transmission tariffs; this might generate pressure for a more structured and transparent process for the selection of cross-border network upgrades as well as for their cost split.

Addressing those weaknesses in the context of the alternative tariff model is straightforward, since it just requires assigning a fixed portion of the revenue requirement of the European transmission network to each Member State. In this way, the total burden placed on each Member State would not depend on its citizens' consumption[17].

2.2. Cost recovery through entry charges into the EU system and exit charges to distribution networks and large end-consumer sites

Under this scheme, which we refer to as model 2, entry from and exit to interconnecting transmission networks within the EU are not charged, while entry charges at the EU system's borders make up for the missing revenues.

Both model 1 and model 2 remove the main cause of location gas price spreads between market zones, by setting equal to zero the cross-border tariffs within Europe. However, from an efficiency perspective, distortions in the supplier merit order could result with model 2, in case different unit charges were applied

[15] In addition to any domestic revenue requirement.

[16] Including inter-TSO compensation.

[17] Fairness dictates that a set of transmission rights corresponding to each State's fixed share of the cost of the transmission network be assigned to the State. In case transmission capacity along a route crossing became scarce, countries owning rights along that route would appropriate their value, either by using them to import gas or by selling them in the market.

at different points of entry into the European system. This does not happen with model 1, which makes the transportation cost to a destination completely independent of where the gas is injected into the European transmission system.

In addition, transmission charges at the entry point of the European network increase the importers' variable cost and therefore the European wholesalers' variable cost. In a less than perfectly competitive market, a commodity's equilibrium prices reflect a positive mark-up on variable costs. Hence, if the market for importing gas into Europe or the internal wholesale market are imperfectly competitive, the gas price to European consumers will reflect, under model 2, one or multiple oligopolistic mark-up on transmission cost. This would not happen if transmission charges are applied further downstream in the value chain, as in model 1.

The ability of model 2 to charge differently at different entry points into the EU system may give the possibilityto extract rents from infra-marginal upstream gas suppliers, to the advantage of European gas consumers. Consider for example a scenario in which: *i)* abundant excess entry capacity and a high level of internal interconnection eradicate any market power by pipeline suppliers, *ii)* LNG is the price setting source of natural gas to Europe and *iii)* pipeline suppliers are price-takers. In this scenario, European customers would benefit from the following tariff structure:

- no charges at LNG entry points: in this way, the wholesale European gas price would not be impacted by transmission tariffs;
- charges at pipeline entry points, possibly higher for those entry points delivering supplies from captive exporters, i.e. exporters unable to export gas to any significant markets other than Europe.

Thanks to this tariff structure, European consumers appropriate, in the form of transmission revenues which they should otherwise pay for, part of the difference between the wholesale gas price and the captive exporters' production cost. Assessing feasibility and the likelihood of success of such a form of discrimination among non-EU gas suppliers to Europe is beyond the purpose of this paper. We note, though, that transmission tariffs may not be the best instrument for that purpose, since policy tools specifically designed to regulate international trade, including import taxes and custom duties, are available to public authorities.

Finally, note that model 2 can be implemented without changing the level of the exit tariffs from the transmission to distribution networks and larger consumers' premises. This means that consumers do not perceive any transmission tariff increase compared to the current system. This happens because with model 2 the missing revenues from intra-EU charges are made up for through the entry charges at the EU borders, which are embedded in wholesale gas prices prevailing in the destination country. On the contrary, with model 1 the missing revenues from intra-EU charges is made up for through the exit charges from the transmission network to the distribution system, that are passed on to consumers directly. That feature may make model 2 more appealing to regulators, to the extent that it spares them to justify to their constituency a transmission-tariff increase whose benefits – taking the form of a wholesale price reduction – may not be easy to demonstrate[18].

3. An investigation of capacity bookings, gas flows and transmission cost data

In order to investigate the empirical effects of the current and alternative tariff methodologies, we analyzed data on physical gas flows, commercial transactions between EU countries and upstream suppliers, and

[18] However, replicating with model 2 the distributional effects of the current system might be impossible without modifying also exit tariffs from the transmission to distribution networks and larger consumers' premises.

capacity bookings from multiple sources, including ENTSOG's Transparency Platform, Eurostat and the Transmission System Operators' websites. We present our database in the Appendix 1.

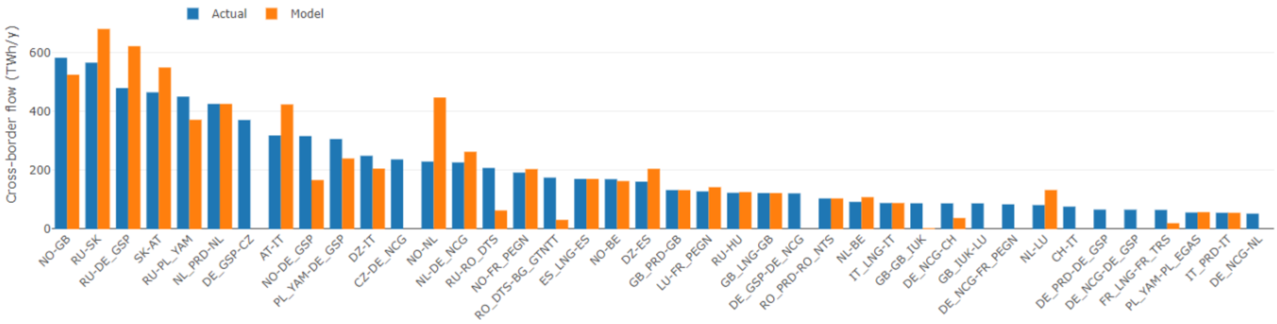
In the rest of this section, we present the results of our analysis, organised around the questions that might be relevant in the policy discussion.

3.1. Are observed intra EU capacity bookings consistent with the relative cost of alternative transmission routes?

The following chart compares the gas flows in the European transmission network in the year 2017 with the flow pattern that would minimise total intra-EU shipping payments (hereafter: the optimal flows).

We computed the optimal flows assuming that injections at the European border, domestic production and consumption are equal to the observed values; further, shipping payments are computed according to current charges for yearly capacity reservations.

Chart 1. Cross border flows: actual vs optimal (TWh/y)



The table shows, firstly, that optimal flows are materially different from the observed flows. In particular, the optimal solution:

- makes greater use of a smaller number of pipelines
- replaces flows through the DE_CZ_DE path with imports through the RU_DE path
- delivers to Southern Europe only gas from Russia and North Africa, while gas sourced from Northern Europe tends to be consumed in Central Europe and the United Kingdom.

A likely explanation for the divergence between actual and optimal flows is the effect of long-term capacity allocations. The opportunity cost of a transmission right for its holder[19] is higher or lower than the tariff in case transmission capacity turns out to be, respectively, scarce or redundant at the time when the right is exercised. The difference between the tariff and the market value of the market participants' portfolios of transmission rights is then likely to be larger the more distant the time capacity was acquired. One can think of optimal flows as those resulting in case no long-term capacity commitments were in place; in this case the cost of transmission is effectively variable, and equal to the tariff, for the shippers.

For the purpose of computing the transmission revenues generated by different flow patterns, we assume that capacity bookings match flows. This assumption is simplistic. However, the difference in transmission revenues obtained under this assumption can be regarded as a lower limit to the loss of revenues that the European Transmission System Operators would suffer, other things being equal, in case the existing set of

[19] Neglecting, for simplicity of exposition, the tariff components that are based on the actual use of booked capacity.

long-term contracts expired and market participants turned to procuring transmission capacity on a short-term (yearly) basis. This is likely to be the case as:

- capacity bookings can be expected to be larger than average yearly flows, to address seasonal modulation of demand[20]
- the existing set of capacity reservations, reflecting long term commitment assumed under pre-crisis expectations of gas consumption, are likely to be larger than what is necessary to implement the observed flows.

Under our conservative assumption, the difference between revenues corresponding to the observed and the optimal flows is about 1 bil. € for year 2017, around 10% of the revenue allowance of the European system operators that we estimate around 10 bil. €[21].

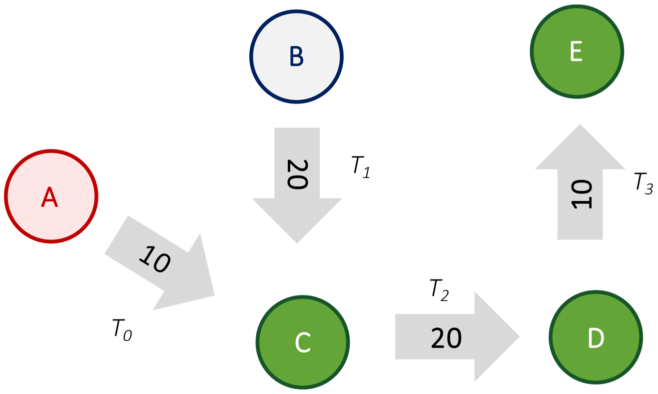
In conclusion, our analysis supports the view that, other things being equal, once the existing long-term contracts expire, the EU Transmission System Operators as a whole will experience a major revenue shortfall unless the average level of transmission capacity is raised. Further, the revenue deficit will not be spread uniformly across all system operators, which will create pressure for some form of inter-TSO and/or inter-country compensation.

3.2. How is the cost of the European transmission network split among consumers connected in different Member States?

Assessing the share of the European transmission network's cost borne by each country, under the current allocation and tariff arrangements, is both conceptually and practically difficult, for two reasons. Firstly, the long-term capacity reservations result in an allocation of the network cost to holders that is independent from the actual demand for transmission services. This implies that, in case of excess capacity, the holders of long-term transmission rights might find it impossible to pass on to their clients, and ultimately to customers, the entire shipping cost.

Secondly, multiple contractual patterns are compatible with the same set of physical flows; each contractual pattern implements a different split of the network cost among the different destination countries and, via the infra-marginal rents, the upstream suppliers. An example of multiple shipping paths is provided in the following figures.

Figure 1: Example, optimal gas flows on the transmission network



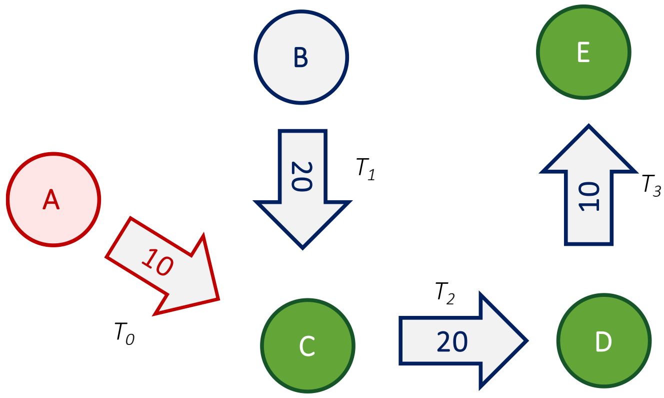
[20] For the part that is not dealt with by using storages or other forms of flexibility

[21] European network total revenue requirement as the product of: 2017 booked capacity and applicable unitary tariff for firm capacity, for each entry and exit point at EU level. Data source: ENTSO's Transparency Platform and the Transmission System Osystem perators' websites.

In the figure, we show *a)* the network topology and transmission tariffs (T_0 to T_3), and *b)* the assumed optimal gas flows from the upstream producers (A and B) to the consuming countries (C, D, E).

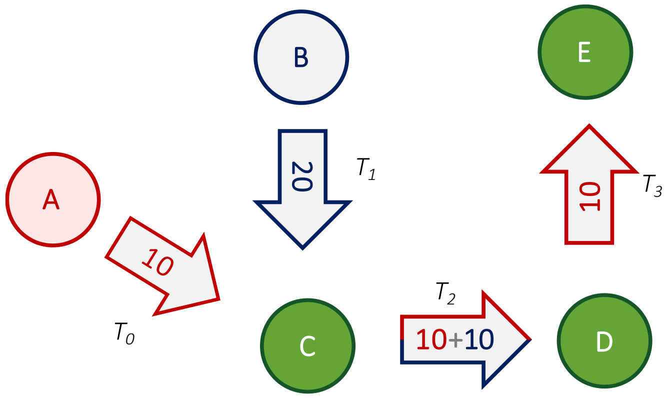
In the next two figures, we present two alternative contractual patterns that generate the same (optimal) flow pattern. Note that the transmission outlay for each destination country is different with each set of contracts[22].

Figure 2 Example, possible contractual path



Transmission cost to supply C = **10** x T_0
Transmission cost to supply D = **10** x T_1 + **10** x T_2
Transmission cost to supply E = **10** x T_1 + **10** x T_2 + 10 x T_3

Figure 3 Example, alternative contractual path



Transmission cost to supply C = **20** x T_1
Transmission cost to supply D = **10** x T_1 + **10** x T_2
Transmission cost to supply E = **10** x T_1 + **10** x T_2 + **10** x T_3

In our analysis, we address the first issue by setting aside any long-term capacity reservations and the second issue by computing the cost allocation under two alternative sets of contract patterns:

[22] For simplicity, we abstract here and in the rest of the paper (but for section 3.2) from the split of the transmission cost between the destination country and the upstream suppliers.

- *Assumption A*: we consider the observed gas flows and we assume a contract pattern that mimics to the largest possible extent observed gas flows. We describe in the Appendix 2 how we derived the set of contracts under Assumption A.
- *Assumption B*: we consider the optimal gas flows and assume a set of contracts consistent with such flows. As discussed above, the cost allocation among countries corresponding to that contract pattern is not the only possible one. For the purpose of this analysis, we have selected a plausible solution, while leaving to further research an investigation into the range of cost allocations among EU countries consistent with a given flow pattern. We describe in the Appendix 2 how we derived the set of contracts under Assumption B.

Under both sets of Assumptions, we retain the observed pattern of injections at the borders and net consumptions of the EU countries, based on Eurostat data, allowing (only) for different delivery routes.

The following tables illustrate how the cost of the transmission network is split among the EU countries for the contract pattern corresponding to each assumption.

Table 1. Share of European transmission network paid by consumers of each Member State

	Share of MS consumption on total EU consumption	Share of total EU network cost born by the MS	
		ASSUMPTION A	ASSUMPTION B
AT	2,0%	1,8%	1,7%
BE	3,9%	2,5%	2,2%
BG	0,7%	2,5%	0,8%
CZ	1,7%	2,8%	2,9%
DE	22,0%	14,7%	17,0%
DK	0,6%	0,7%	0,7%
EE	0,1%	0,1%	0,1%
ES	6,6%	10,5%	10,2%
FR	11,0%	9,0%	9,4%
GB	15,6%	8,3%	9,3%
GR	1,0%	2,0%	1,9%
HR	0,9%	2,6%	2,4%
HU	2,2%	3,4%	2,6%
IE	0,6%	2,1%	2,2%
IT	14,8%	23,8%	23,8%
LT	0,5%	0,2%	0,2%
LU	0,2%	0,3%	0,1%
LV	0,0%	0,0%	0,0%
NL	7,3%	3,8%	3,7%
PL	3,8%	1,5%	2,1%
PT	1,3%	4,5%	4,2%
RO	2,3%	1,2%	1,4%
SE	0,2%	0,3%	0,2%
SI	0,2%	0,3%	0,3%
SK	0,6%	0,9%	0,5%
TOT	**100,0%**	**100,0%**	**100,0%**

The table shows that the allocations of the total transmission cost among countries is broadly similar under the two assumptions on the contract paths. This result is subject to two qualifications: first, the set of contracts implicit in Assumption B is one of the possibly many compatible with the optimal flow pattern; second, total shipping cost under Assumption B is lower than under Assumption A, as discussed above.

Note that the difference, in some cases material, between each country's share of total consumption and the share of total network cost borne by the country, reflects at least the following factors:

- the "distance" as reflected in the transmission tariffs, between the country's border and the point of entry into the European system through which the country is supplied
- differences in each country's cost for the domestic portion of the transmission network.

3.3. May the current tariff system cause distortions in the European gas market?

The following table reports information on the average cost, based on current transmission tariffs, of shipping gas from different points of entry into the European transmission network to each country's border. We weight the cost of alternative routes between a source-destination couple based on the contract pattern obtained under Assumption A in the previous section[23].

Table 2. Minimum shipping cost to move gas from point of entry into EU to Member States (€/MWh)

	North Africa	NL	NO	RU	TR	Range	weight on average EU natural gas price
AT	1,12	1,11	1,16	0,89		0,27	2%
BE	2,66	0,38	0,15	0,89		2,52	15%
BG	2,85		2,88	0,79	1,38	2,10	12%
CZ	2,07	0,84	0,74	0,52		1,55	9%
DE	1,92	0,49	0,39	0,17		1,75	10%
DK	3,17	1,20	0,16	0,88		3,01	18%
EE				0,31		0,00	0%
ES	0,36					0,00	0%
FR	1,44	0,78	0,28	1,02		1,16	7%
GB	3,08	0,79	0,12	1,30		2,95	18%
GR				1,61	0,53	1,09	6%
HR	2,61	2,86	2,91	1,66		1,24	7%
HU	1,79	1,78	1,83	0,54		1,29	8%
IE	4,30	2,02	1,35	2,53		2,95	18%
IT	0,83	1,90	1,95	1,68		1,12	7%
LT				0,09		0,00	0%
LU	1,82	0,33	0,44	0,56		1,49	9%
LV				0,09		0,00	0%
NL	2,29		0,11	0,51		2,18	13%
PL	3,05	1,08	0,99	0,39		2,66	16%
PT	1,42					0,00	0%
RO	2,38	2,36	2,41	0,31		2,10	12%
SE	3,69	1,73	0,69	1,41		3,01	18%
SI	1,55	1,80	1,84	1,58		0,30	2%
SK	1,54	1,45	1,35	0,29		1,25	7%

2017 average price for gas import into EU (€/MWh)*	**16,85**

[23] In case locational arbitrage is effective, i.e. under Assumption B, the possible distortions caused by transmission tariffs in the selection of upstream suppliers can be expected to reduce. This happens because, under Assumption B, physical flows within Europe depart from those matching import transactions, if that allows to minimize intra-EU transmission cost. We leave the investigation of distortions under Assumption B to further research.

The table shows that the cost of shipping gas to a EU country from different points of entry into the European network is materially different. Some shipping cost differences are in the same order of magnitude as the differences in gas prices between different upstream supply sources.

Based on this evidence, one cannot rule out the possibility that the current tariff model, possibly interacting with market imperfections that prevent full arbitrage among shipping routes, causes inefficiencies in the selection of the upstream suppliers.

3.4. What would be the impact of alternative models on the tariff levels?

Model 1

With model 1, each country is allocated the same share of total EU transmission cost that the country would bear with the current methodology.

As discussed in section 3.2 assessing the share of the EU transmission cost falling on each country's customers under the current system entails some arbitrary assumptions on the contract pattern. We split our estimated 10 bil € total allowed revenues among the European countries according to Assumption A and Assumption B of section 3.2[24].

Model 1 prescribes that the cost allocated to each country be entirely covered via exit charges from the country's transmission system to the country's distribution system and directly connected costumers (hereafter: the domestic exit charges), while all other charges are set to zero. We find that Model 1 implies an average increase of 1.84 €/MWh of the domestic exit charges. The following table reports the change in each country's domestic exit charges implementing model 1.

[24] Recall from section 3.2 that under Assumption B the total revenue collected by the system operators is at least 1 bil€ below the observed level (10 bil€), which is instead achieved under Assumption A. For this reason, in order to make the two sets of tariffs comparable, in this section we have scaled up proportionally the cost allocated to all countries under Assumption B, until total outlays reached the observed level.

Table 4. Model 1: Average domestic exit-charge increase under assumption A and B

	Current average domestic exit charge (€/MWh)	Domestic exit charge increase under model 1 / assumption A	Domestic exit charge increase under model 1 / assumption B
AT	0,26	569%	549%
BE	-	0%	0%
BG	0,71	904%	212%
CZ	1,26	148%	152%
DE	0,50	150%	190%
DK	1,14	95%	99%
EE	1,49	84%	77%
ES	1,79	68%	64%
FR	0,52	164%	178%
GB	0,69	48%	67%
GR	1,34	170%	161%
HR	2,57	103%	86%
HU	0,87	220%	144%
IE	3,43	95%	101%
IT	0,92	236%	234%
LT	0,51	74%	66%
LU	1,07	255%	56%
LV	-	0%	0%
NL	0,39	104%	93%
PL	0,23	226%	367%
PT	3,30	90%	76%
RO	0,69	38%	61%
SE	-	0%	0%
SI	0,63	476%	417%
SK	0,79	266%	101%
TOT	**0,75**	**144%**	**144%**

The table shows that tariff model 1 entails a material and non-uniform increase in domestic exit charges, to make up for the revenues lost by setting to zero all other transmission charges. Relative to the average import price of gas to Europe, the average domestic exit charge would increase from 4,4% to 6,5%.

Model 2

In model 2, as in model 1, entry and exit through intra EU interconnections are not charged; however, in model 2 the missing revenues are offset via the charges at the point of entry into the European system. We consider two possible ways to implement model 2. In the first case, entry charges into the EU are uniformly increased, in absolute terms. In the second case, larger tariff increases are implemented at the borders where gas prices are (currently) lower, with the purpose of extracting the upstream supplier's rent. In particular, we assume that border tariffs can be increased until the sum of gas border prices and entry tariffs at all borders is equal. In doing so we assumed the following gas border prices:

Table 5. 2017 average gas price of main suppliers (€/MWh)

Supplier	NA (North Africa)	NL	NO	RU
Average gas price	17,60	18,42	17,88	14,79

Source: EUROSTAT COMEXT, foreign trade statistics database.

The following table presents the entry charges at the EU borders under model 2. In the "uniform charging" option, model 2 entails setting a uniform charge at all points of entry into the European system that generates 5,7 bil. €, equal to the revenues currently obtained from intra-EU cross border charges and the current entry charges at the EU borders.

In the "rent-extraction" option, model 2 entails increasing tariffs at the borders until either the infra-marginal rents are completely extracted or the revenue target is achieved. Based on our price data, the Netherlands is the marginal supplier, and therefore sets the EU gas prices, while the other upstream suppliers match that price[25]. By considering the prices shown in table 5 as the suppliers' reservation prices, each infra-marginal supplier would obtain an infra-marginal rent equal to the difference between the Dutch price and price reported in the table.

We set the tariffs at the entry points into the European system in such a way that the rents of all infra-marginal suppliers are decreased in the same proportion and we find that about 70% of the total infra-marginal rent is sufficient to cover the entire revenue requirement of 5,7 bil. €.

Table 6. Average entry charge increase under Model 2.

	CURRENT ENTRY TARIFF	ENTRY TARIFF MODEL 2 / UNIFORM	ENTRY TARIFF MODEL 2 / RENT EXTRACTION
NA-ES	0,36	1,55	0,57
NA-IT	0,83	2,02	0,57
NO-BE	0,15	1,34	0,38
NO-DE_GSP	0,39	1,58	0,38
NO-DK	0,16	1,35	0,38
NO-FR_PEGN	0,28	1,47	0,38
NO-GB	0,12	1,31	0,38
NO-NL	0,11	1,30	0,38
RU-DE_GSP	0,17	1,36	2,53
RU-EE	0,31	1,50	2,53
RU-FL	0,31	1,50	2,53
RU-HU	0,54	1,73	2,53
RU-LT	0,09	1,28	2,53
RU-LV	0,09	1,28	2,53
RU-PL_YAM	0,39	1,58	2,53
RU-RO_DTS	0,31	1,50	2,53
RU-RO_NTS	0,31	1,50	2,53
RU-SK	0,29	1,48	2,53
TR-GR	0,53	1,72	0,00
NL-BE	0,13	0,00	0,00
NL-DE_NCG	0,36	0,00	0,00
NL-LU	0,08	0,00	0,00

The following table shows how the European network costs are split among the Member States if model 2 is implemented without any form of inter-country compensation, under the contract patterns implied by Assumptions A and Assumption B of section 3.2[26]. Note that the shares reported in the table for the option "rent extraction" correspond to just 4.3 bil. € revenues, because the remaining 5.7 bil. € would be extracted from the upstream suppliers via the entry charges into the EU.

[25] An investigation of the reasons for the observed price differentials in import prices from different upstream suppliers is beyond the purpose of this paper.

[26] Since the infra-marginal rent is sufficient to cover the entire entry revenue requirement, the shipping flow pattern affects the allocation of cost among countries only with the uniform-charging option.

Table 7. *Share of EU network cost borne by each MS under Model 2*

	CURRENT SITUATION		Model 2 Uniform Charging /ASSUMPTION A	Model 2 Uniform Charging /ASSUMPTION B	Model 2 with RENT EXTRACTION
	Share of MS consumption on total EU consumption	Share of total EU network cost born by the MS	Share of total EU network cost born by the MS	Share of total EU network cost born by the MS	Share of total EU network cost born by the MS
AT	2,0%	1,8%	1,8%	1,8%	0,6%
BE	3,9%	2,5%	2,6%	3,2%	2,4%
BG	0,7%	2,5%	2,9%	0,7%	0,6%
CZ	1,7%	2,8%	2,5%	2,6%	2,6%
DE	22,0%	14,7%	19,5%	22,5%	14,2%
DK	0,6%	0,7%	0,8%	0,8%	0,8%
EE	0,1%	0,1%	0,3%	0,2%	0,2%
ES	6,6%	10,5%	9,0%	9,3%	14,5%
FR	11,0%	9,0%	9,3%	8,8%	9,5%
GB	15,6%	8,3%	12,3%	12,4%	12,9%
GR	1,0%	2,0%	1,3%	1,3%	1,8%
HR	0,9%	2,6%	1,6%	1,6%	3,1%
HU	2,2%	3,4%	3,8%	3,1%	2,7%
IE	0,6%	2,1%	1,5%	1,2%	2,5%
IT	14,8%	23,8%	17,3%	17,8%	16,3%
LT	0,5%	0,2%	0,6%	0,3%	0,3%
LU	0,2%	0,3%	0,2%	0,1%	0,2%
LV	0,0%	0,0%	0,0%	0,0%	0,0%
NL	7,3%	3,8%	3,2%	4,8%	5,2%
PL	3,8%	1,5%	2,8%	2,5%	1,0%
PT	1,3%	4,5%	2,9%	2,7%	5,7%
RO	2,3%	1,2%	1,1%	1,1%	2,2%
SE	0,2%	0,3%	0,1%	0,1%	0,0%
SI	0,2%	0,3%	0,2%	0,2%	0,1%
SK	0,6%	0,9%	2,2%	0,7%	0,6%
TOT	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**

4. Concluding remarks

The entry-exit model currently in place has been key to the overall positive development of the EU gas market in recent years. However, since the release of the Third Package (2007), when the entry-exit model looked like the most appropriate choice for that time's needs, the EU gas market's fundamentals have changed. In particular, the fact that a sizable portion of the existing capacity was allocated to market participants under long term contracts currently still mitigates the distortive impact of the current tariff methodology on the gas market outcome.

Our empirical analysis suggests that once such long-term commitments expire, even more tangible distortions may arise. In particular, we found, that: *i)* current gas flow patterns in Europe are different from those that minimize intra-EU shipping cost at the current transmission tariffs; we conjecture that this feature is related to the existing stock of long-term capacity holdings; *ii)* in case the optimal flow pattern were implemented, i.e. once the existing set of long-term transmission rights expires, a material reduction in the overall tariff revenues might occur; further, the revenue shortfall might be unevenly split among routes and Transmission System Operators; *iii)* the cost of shipping gas to a European country from different points of entry into the European network is materially different, to the point that one cannot rule out the possibility that the current tariff model has an impact on the selection of the upstream suppliers.

In this paper we have assessed pros and cons of two possible replacements to the current tariff methodology. With the first alternative methodology, the entire revenue requirement is met by charging the transmission's exit points towards distribution networks and directly connected end-customers. We argue that this methodology is superior to the current one and to the alternative option in terms of efficiency; further, it may be implemented in a way that broadly replicates the current sharing of the overall network cost among the European citizens. A move to this model entails material increases of domestic transmission tariffs, which, under plausible assumptions on the wholesale gas price formation mechanism, would be more than offset by commodity price reductions. This feature could make the methodology unappealing to national authorities, which would have to justify to their constituency a transmission-tariff increase whose benefits – in terms of commodity price reduction – may be hard to demonstrate.

With the second methodology, entry from and exit to interconnecting transmission networks within the EU are not charged and charges at the entry point of the European system make up for the missing revenues. Although less appealing in terms of efficiency, this model does not require increasing domestic transmission tariffs. Further, it may allow extracting rents from infra-marginal upstream gas suppliers, to the advantage of European gas consumers.

Appendix 1 – the dataset

In this appendix we focus on describing the dataset employed in our analysis. We start with a short investigation into data availability regarding capacity, physical flows, tariff and TSOs' allowed revenues data.

Data availability and sources

European TSOs publish data on a Union-wide central platform, ENTSOG TP (TP)[27], which was established in 2013 to fulfil the requirements of Regulation (EC) No 715/2009[28]. ENTSOG TP provides technical and commercial data on entry and exit points of the EU gas transmission system, which includes cross-border interconnection points (ITP), storage connections, entry point from production and LNG facilities, exit point to distribution networks and final consumers.

ENTSOG TP provides historical capacity, physical flow and tariff data about all EU entry and exit points. Being the most complete database currently available, it was used as our primary source of data.

In addition to data published on the ENTSOG Transparency platform, most TSOs publish on their websites historical physical flows, capacity and applicable tariffs for each entry and exit point they operate. However, it is not very easy to make use of this information in comparative studies at EU level because:

- European TSOs publish data expressed in different units of measurement;
- There is a lack of documentation in English and/or very poor website's English sections;
- There is a general lack of standardisation between published documents.

Moreover, Chapter VIII of the Tariff Network code (TAR NC)[29] requires that each TSO shall publish transmission allowed revenues and tariff information at interconnection points before the annual yearly capacity auction. Chapter VIII's provisions apply as from 1 October 2017.

TSOs shall publish information including:

- reserve price for firm and interruptible products;
- cost of capital and methodology to determine the Regulatory Asset Base (type of assets included and their aggregated value);
- transmission services revenue;
- a simplified tariff model enabling network users to calculate the transmission tariffs

In March 2018, when we started collecting data, information required by Chapter VIII of the TAR NC were not available for all European TSO's. Furthermore, in some cases, information was not easily comparable with other TSO's data because methodology was not straightforward or completely missing.

[27] https://transparency.entsog.eu/

[28] Annex I, Chapter 3 of Regulation (EC) No 715/2009 defines the technical information necessary for network users to gain effective access to the system, the definition of all relevant points for transparency requirements and the information to be published at all relevant points and the time schedule according to which that information shall be published. Relevant points shall include: a) all entry points to a network operated by a transmission system operator; b) the most important exit points and exit zones covering at least 50 % of total exit capacity of the network of a given transmission system operator; c) all points connecting different networks of transmission system operators; d) all points connecting the network of a transmission system operator with an LNG terminal.

[29] Commission Regulation (EU) 2017/460 of 16 March 2017 establishing a network code on harmonised transmission tariff structures for gas.

The dataset

Our dataset includes 2017 physical flows, technical capacity, booked capacity and applicable tariff data for all entry and exit points in the European Union. It also includes an assessment of 2018 allowed revenues for each European TSO.

Entry and exit points are classified into the following categories:

- Interconnection points (ITP),
- Production entry points (PRD),
- Liquefied Natural Gas entry points (LNG),
- Distribution exit point (DIS),
- Final consumers exit points (FNC),
- Underground gas storage (UGS).

For each EU entry and exit point we considered the following data referring to calendar year 2017[30]:

- Firm technical capacity and total interruptible capacity (hereafter “total capacity”);
- Firm and interruptible booked capacity (hereafter “booked capacity”);
- Physical flows;
- Applicable tariffs for yearly capacity products;

ENTSOG TP is our database primary source of data. However, when we started to analyse data we run into some inconsistencies:

1. Conflicting physical flow data on cross-border interconnection point.

At times, entry and exit flows data at interconnection points (ITP) do not match.

For each ITP, ENSOG TP returns data on entry and exit flows reported by all TSOs which network is connected to the point. Often, different TSOs operating at the same interconnection point report conflicting data (e.g. an ITP connects TSO A and TSO B’s networks and gas flows from A to B. Exit physical flow data reported from TSO A is different from Entry physical flow data reported from TSO B).

Aiming to obtain a complete and consistent dataset, we check each conflicting physical flow data on ITPs and look for the more reliable data, cross-checking all available public data sources (mostly TSOs’ websites and NRAs’ documentation)[31]. As a result, we set all physical flows data on a single ITP at the same value (equalizing entry and exit flows at each ITP).

2. Incomplete physical flows and capacity data at domestic exit point.

Domestic exit points data are often incomplete: some points appear to register no physical flow and points with relevant physical flows appears to have no booked capacity. Furthermore, considering each TSO’s network data individually, total inflows often exceed total outflows. This resulting in an “imbalance”: gas entering the system exceeds gas exiting the same system.

In order to obtain a complete and consistent dataset, we estimate missing capacity and physical flows data at exit points to distributors and final consumers. For each TSO we compute physical flows at domestic exit points as the difference between total entry flows into the network and total exit flows from the same network. In doing so, we manage to balance all TSOs’ networks, levelling inflows and

[30] Most recent data on a full calendar year when we started our analysis.

[31] Often data reported to ENTSOG was conflicting with data published on TSOs’ websites.

outflows. In Table 8 we test our data, aggregated by Member State, against Eurostat 2017 gross inland consumption.

Furthermore, where capacity data on domestic exit points is missing, we assess the booked capacity as: physical flow * α, where α is the average booked capacity/physical flow value at EU level obtained from available data on domestic exit points.

***Table 8**. 2017 physical flow data from our dataset and Eurostat 2017 Gross inland consumption data (GWh/y).*

Member State	Entry from Int. Points (ITP)	National production	Liquefied Natural Gas	Underground Gas Storage		Exit to Int. Points (ITP)	Distribution and Final Consumers	2017 Gross inland consumption (Eurostat)
	Entry	Entry	Entry	Entry	Exit	Exit	Exit	
DE	1.667.041	67.007	-	220.957	- 241.393	- 735.337	- 1.149.096	994.175
GB	632.983	132.799	122.644	32.397	- 45.524	- 123.734	- 813.034	874.518
IT	644.811	55.514	88.644	119.707	- 116.712	- 1.327	- 773.786	795.339
FR	449.736	-	104.239	133.084	- 120.844	- 68.380	- 571.990	497.836
NL	398.512	426.173	8.465	143.443	- 108.368	- 464.138	- 378.967	401.024
ES	205.659	109	170.718	2.945	- 2.712	- 30.333	- 346.386	352.411
BE	471.137	-	12.238	10.129	- 6.791	- 303.910	- 201.542	182.148
PL	458.289	17.039	18.528	23.191	- 24.511	- 320.456	- 198.035	202.049
RO	220.703	104.334	-	21.269	- 18.885	- 208.190	- 118.053	132.127
HU	168.449	24.828	-	23.230	- 38.571	- 62.337	- 115.599	110.359
AT	510.894	-	-	-	-	- 408.267	- 102.627	99.843
CZ	374.316	-	-	25.693	- 29.988	- 279.519	- 90.503	93.056
PT	30.282	-	39.060	1.873	- 2.439	- 429	- 68.347	70.644
GR	36.759	-	15.413	-	-	-	- 52.171	54.177
HR	19.980	12.435	-	15.187	-	-	- 47.601	33.861
BG	207.882	586	-	3.502	- 3.450	- 174.237	- 34.386	34.229
DK	44.627	-	-	-	-	- 12.827	- 31.800	35.390
SK	602.454	-	-	-	-	- 570.979	- 31.475	50.787
IE	36.335	-	-	-	-	- 4.983	- 31.352	55.781
LT	40.446	-	12.360	-	-	- 28.287	- 24.520	24.765
SI	22.836	-	-	-	-	- 13.106	- 9.730	9.729
LU	8.985	-	-	-	-	-	- 9.045	8.957
SE	8.717	-	-	-	-	-	- 8.717	8.688
EE	18.228	-	-	-	-	- 12.981	- 5.247	5.257
LV	2.536	-	-	-	-	-	- 2.536	13.307
Total	**7.282.596**	**840.825**	**592.310**	**776.606**	**- 760.186**	**- 3.823.755**	**- 5.216.546**	**5.140.454**

Physical flows data collected in our dataset appears to be consistent with Eurostat consumption data.

3. Off-scale or incomplete tariff data.

In some cases, applicable tariff data from TP database results are materially different from those published on TSOs’ websites. At times, applicable tariff data are completely missing or set to zero.

Therefore, we verify and complete applicable tariff data, cross-checking data on TSOs’ website tariff sections or, where available, tariff information published under TAR NC Chapter VIII provisions.

Applying tariffs to 2017 booked capacity, we obtain an assessment of each TSO annual revenues. In Table 9. we test our results against allowed revenues data published by TSO under TAR NC Chapter VIII provisions (where available).

***Table 9.** 2017 TSO's revenues data resulting from our dataset and 2018 TSO's revenues data published under TAR NC Chapter VIII provisions, aggregated by Member State (€ million/year).*

Member State	Entry from Interconnection points	National production	Liquefied Natural Gas	Underground Gas Storage	Virtual Trading Point	Exit to Interocnnection points	Distribution and Final Consumers	Total Revenues	Allowed revenues from TAR NC tranparency report
DE	639	43	-	5	-	526	573	1.786	2.059
IT	648	-	-	-	-	0	713	1.361	1.377
GB	325	-	-	-	-	164	562	1.051	1.080
FR	199	-	27	88	-	229	300	843	1.998
ES	88	0	12	-	-	57	621	778	1.000
NL	93	80	-	-	-	250	149	572	882
SK	231	-	-	-	-	378	25	634	760
AT	76	-	-	-	-	319	27	422	424
PL	234	-	-	-	-	112	45	391	360
PT	71	-	17	8	-	1	226	322	81
CZ	46	-	-	0	-	159	114	319	170
BE	63	-	2	-	103	139	-	308	397
HU	94	16	-	-	-	43	101	253	N/A
RO	0	0	-	13	-	143	81	237	205
IE	70	-	-	-	-	16	108	193	177
HR	32	12	-	-	-	-	122	166	176
BG	73	-	-	-	-	37	25	135	131
GR	25	-	7	-	-	-	70	102	175
EE	27	-	-	-	-	19	8	54	N/A
DK	2	-	-	-	-	7	36	46	55
LT	6	-	2	-	-	7	12	27	19
LU	10	-	-	-	-	-	10	20	N/A
SI	9	-	-	-	-	4	6	19	46
LV	1	-	-	0	-	0	-	2	31
SE	-	-	-	-	-	-	-	-	N/A
Total	**3.064**	**150**	**67**	**114**	**103**	**2.611**	**3.933**	**10.041**	**11.603**

Our assessment of yearly revenues appears to be inconsistent with TSO's allowed revenues statements. Total revenues computed through our dataset are much lower than allowed revenues as stated by TSOs under the TAR NC transparency requirement.

This could be partially explained because:

- the dataset considers one single tariff for firm capacity and one for interruptible capacity products– the yearly product tariff. This could potentially underestimate revenues from shorter term products;
- TSOs' revenues from national production entry points are underestimated because applicable tariff data from ENTSOG TP is often incomplete and we were not able to find all relevant information elsewhere;
- some TSOs publish only aggregated allowed revenues and do not differentiate between transmission related activity and other activities: allowed transmission-related revenues data from TAR NC transparency report and TSO's financial statements could be overestimated.
- the dataset does not consider any TSO auction revenue;
- The comparability of data is poor: we are comparing data referring to 2 different years (2017 and 2018). Unfortunately, only 2018 allowed revenues data published under TAR NC Chapter VIII provisions where available (as a matter of fact, Chapter VIII's provisions only apply as from 1 October 2017).

In short our dataset seems to underestimate EU transmission related yearly revenues by at least 10%.

The following table summarises sources and computing methodologies (where data is missing or incomplete) for each type of data included in the dataset.

Table 10. *Data source and computing methodology for each type of data*

	Data	Source	Computing Methodology (where data is missing or incomplete)
A	physical flow	Entsog / TSO / NRA	for each TSO, exit DIS & FNC points' physical flows = ∑Entry physical flow - ∑Exit physical flow
B	total capacity	Entsog	-
C	booked capacity	Entsog / TSO	for exit DIS & FNC points: A * α wher α is the average C / A value for available distribution and Final consumers data
D	applicable tariff	Entsog / TSO website / TSO transparency report	-
E	TSO revenues	-	C * D

Appendix 2 – Gas flows, contract patterns and cost allocation among Member States

As shown in section 3.2, multiple contractual patterns are compatible with the same set of physical flows, and each contractual pattern implements a different split of the network cost among the different destination countries.

In our analysis, we address this issue by computing the cost allocation under two alternative sets of contract patterns:

<u>Assumption A: we consider the observed gas flows and we assume a contract pattern that mimics to the largest possible extent observed gas flows.</u>

In this paragraph we explain how we assess contractual patterns that fit observed gas flows and how we manage to identify the paths deployed to transport gas from suppliers to each MS.

We consider two different sources of data:

1- *Physical flows* data from the dataset described in annex 1
   we consider physical flows at each "border" between two Member States: in order to do that, we aggregate physical flows transiting through all interconnection points connecting each couple of countries;
2- *Contractual pattern* between Member States and their main suppliers
   we consider 2017 Eurostat natural gas import data[32], for each MS, as a proxy of main contractual patterns between suppliers and Member States.

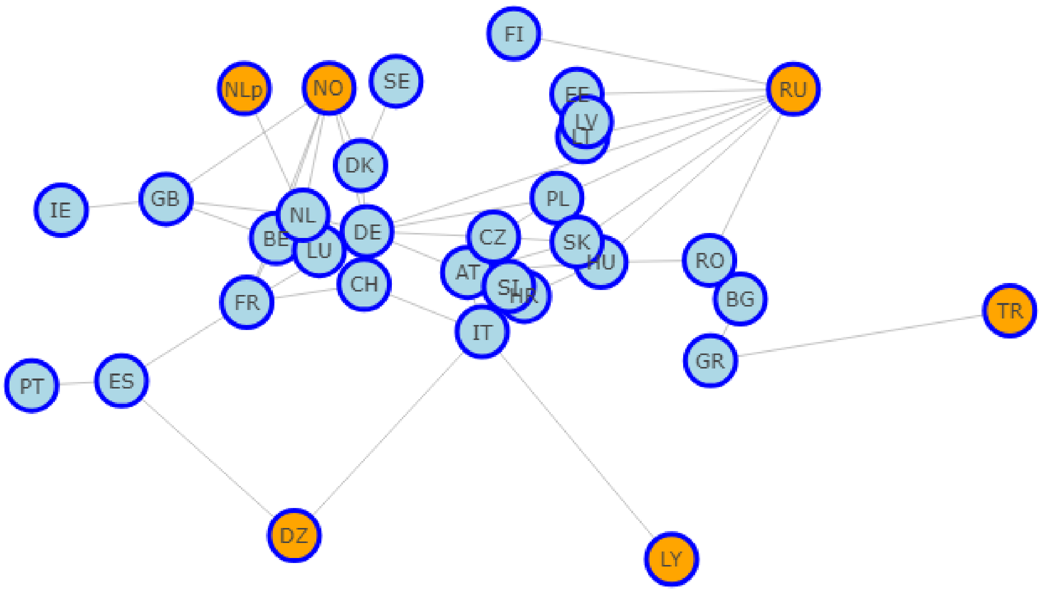
Physical flows data provides information on the volumes of gas transiting from each country to other neighbouring countries, but it gives no information about the origin and the final destination of those volumes. On the contrary, contractual flows data provides information about origin and final destination of gas (e.g. the quantity of gas bought by each MS from Russia), but it does not help in understanding which path the gas takes to reach the destination country and what countries it crosses to do so.

Aiming to reconcile physical and contractual flows data, and to assess the usage of all paths deployed to transport gas from suppliers to Member States, we develop an algorithm which:

A. Build the network structure given all physical flows *f*:
   - *6 suppliers*: Russia, Norway, Nederland, Algeria, Libya, Turkey.
     We introduce a simplification: production and LNG volumes are consumed in the producing country or where the regassification premises are located.
     Volumes from production sites contribute to a decrease in the producing Member States' demand for imports; this does not hold for Dutch production (because production exceeds consumption volumes). In the same way, inflows from LNG contribute to a decrease in the demand for imports of the country hosting the regassification facility.
   - *27 countries*: 26 EU Member States (Cyprus and Malta excluded) and Switzerland.
   - *59 borders*: two countries are connected only if a physical flow between them is observed.

[32] Imports - gas - annual data [nrg_124a], last update: 05.02.2018, extracted on: 16.04.2018, available at: https://ec.europa.eu/eurostat/data/database

Chart 2. *Network structure*



B. Given a supplier country Y and a Member State A, find all paths going from Y to A
Where each path is a set of crossed borders (interconnections).
C. Decision variables: physical flows along paths (φ).
D. Objective function: minimize the difference between the sum of the φ's passing a border and its physical flow f (N.B. the grid is mesh, therefore multiple paths may go through any given border).
E. Constraints:
   - φ may not exceed path "capacity", where path capacity is the annual average physical flow observed for each border.
   - Sum of φ's connecting Y to A must equal its contractual flows.

The algorithm finds feasible paths that reconcile contractual and physical data simulating all physical flows throughout Europe.

As a result, the algorithm allows us to:

- identify all paths transporting gas to each Member State.
  Allowing us to understand how each Member State employs the EU transmission network, and where the gas crossing each Member State is headed (see the following Table 11);
- split the cost of the EU transmission network among Member States.
  In order to do so, we:
  - compute the entry and exit capacity charges at each border (weighted-average calculated on the basis of physical flows if there are more than one interconnection point) [33]. These charges will be employed as the "entry border charge" and the "exit border charge".

[33] in Member States with more than one TSO, there are interconnection points connecting two or more balancing zones, resulting in interconnection points within the same Member State. In order to take into account the

- assess the annual transmission cost at each border as the product between annual physical flow and the entry and exit border charges,
- proportionally allocate the transmission cost of each border to Member States that employ paths passing through that border (see the following Table 12).

For the purpose of allocating the transmission cost of different flow patterns, we assume that capacity bookings match flows. This assumption is simplistic and leads us to underestimate actual costs of EU transmission because:

- capacity bookings can be expected to be larger than average yearly flows, to address seasonal modulation of demand[34]
- the existing set of capacity reservations, reflecting long term commitment assumed under pre-crisis expectations of gas consumption, are likely to be larger than what is necessary to implement the observed flows.

The following tables show our model's output.

transmission costs resulting from entry and exit charges at these points, we reflect these costs on the exit charge on the external border of the Member State. First of all, for each interconnection point, we assess the share of transiting gas (excluding the gas addressed to domestic consumption) and its resulting transmission cost; afterwards, we address this cost to each exit border (proportionally with outflows).

[34] For the part that is not dealt with by using storages or other forms of flexibility.

Table 11. *Assumption A: Gas crossing transit countries to reach destination countries (TWh/y)*

Transit Country

Destination Country	AT	BE	BG	CZ	DE	DK	EE	ES	FR	GB	GR	HR	HU	IE	IT	LT	LU	LV	NL	PL	PT	RO	SE	SI	SK	**total**
AT	-	-	-	4	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	98	**116**
BE	2	-	-	-	29	1	-	-	-	20	-	-	-	-	-	-	-	-	94	3	-	-	-	-	2	**149**
BG	0	-	-	0	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	178	-	-	0	**178**
CZ	2	-	-	-	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	-	-	-	-	5	**142**
DE	2	20	-	-	-	0	-	-	-	9	-	-	-	-	-	-	-	-	150	187	-	-	-	-	2	**370**
DK	2	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2	**15**
EE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	**3**
ES	-	25	-	-	21	1	-	-	39	7	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	**110**
FR	3	154	-	-	89	1	-	-	-	28	-	-	-	-	-	-	-	-	84	5	-	-	-	-	3	**367**
GB	-	16	-	-	8	1	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	**36**
GR	0	-	30	0	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	30	-	-	0	**60**
HR	17	0	-	5	11	-	-	-	0	0	-	-	7	-	0	-	-	-	0	5	-	0	-	13	11	**69**
HU	40	-	-	4	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	0	-	-	33	**93**
IE	-	16	-	-	8	1	-	-	-	31	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	**66**
IT	323	36	-	16	113	2	-	-	17	13	-	-	-	-	-	-	-	-	71	14	-	-	-	1	299	**904**
LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
LU	1	8	-	-	6	1	-	-	-	2	-	-	-	-	-	-	-	-	5	1	-	-	-	-	1	**25**
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	**1**
NL	2	17	-	-	44	1	-	-	-	5	-	-	-	-	-	-	-	-	-	12	-	-	-	-	2	**84**
PL	-	3	-	5	5	0	-	-	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	**16**
PT	-	2	-	-	2	0	-	30	2	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	**38**
RO	0	-	-	0	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	0	**0**
SE	1	-	-	-	2	9	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	**13**
SI	10	0	-	3	6	-	-	-	0	0	-	-	-	-	0	-	-	-	0	3	-	-	-	-	6	**28**
SK	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	**9**
total physical flow transiting	**404**	**297**	**30**	**39**	**466**	**16**	**0**	**30**	**58**	**118**	**0**	**0**	**7**	**0**	**0**	**2**	**0**	**2**	**446**	**289**	**0**	**208**	**0**	**13**	**465**	**2.892**

Table 12. *Assumption A: annual charges paid by destination countries to transit countries (mil.€).*

Destination Country \ Transit Country	AT	BE	BG	CZ	DE	DK	EE	ES	FR	GB	GR	HR	HU	IE	IT	LT	LU	LV	NL	PL	PT	RO	SE	SI	SK	**total**
AT	8	-	-	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	96	**117**
BE	1	17	-	-	23	1	-	-	-	6	-	-	-	-	-	-	-	-	37	3	-	-	-	-	2	**89**
BG	0	-	55	0	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	120	-	-	0	**175**
CZ	1	-	-	8	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	-	-	-	-	4	**107**
DE	1	6	-	-	274	0	-	-	-	3	-	-	-	-	-	-	-	-	60	187	-	-	-	-	2	**534**
DK	1	-	-	-	8	5	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2	**18**
EE	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	**3**
ES	-	8	-	-	18	1	-	68	71	2	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	**177**
FR	1	47	-	-	76	1	-	-	113	9	-	-	-	-	-	-	-	-	35	5	-	-	-	-	3	**291**
GB	-	7	-	-	7	1	-	-	-	51	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	**71**
GR	0	-	30	0	0	-	-	-	-	-	26	-	0	-	-	-	-	-	-	0	-	20	-	-	0	**76**
HR	7	0	-	2	6	-	-	-	0	0	-	19	7	-	0	-	-	-	0	5	-	0	-	8	11	**67**
HU	9	-	-	2	6	-	-	-	-	-	-	-	95	-	-	-	-	-	-	5	-	0	-	-	33	**150**
IE	-	7	-	-	7	1	-	-	-	11	-	-	-	24	-	-	-	-	5	-	-	-	-	-	-	**54**
IT	210	13	-	7	83	2	-	-	24	5	-	-	-	-	502	-	-	-	25	14	-	-	-	1	295	**1.181**
LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	**4**
LU	0	1	-	-	5	1	-	-	-	1	-	-	-	-	-	-	4	-	2	1	-	-	-	-	1	**17**
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	**0**
NL	1	5	-	-	33	1	-	-	-	2	-	-	-	-	-	-	-	-	8	12	-	-	-	-	2	**65**
PL	-	1	-	2	3	0	-	-	-	0	-	-	-	-	-	-	-	-	1	64	-	-	-	-	-	**72**
PT	-	1	-	-	1	1	-	33	4	0	-	-	-	-	-	-	-	-	1	-	59	-	-	-	-	**99**
RO	0	-	-	0	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	-	0	**0**
SE	0	-	-	-	2	21	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	**24**
SI	5	0	-	1	4	-	-	-	0	0	-	-	-	-	0	-	-	-	0	3	-	-	-	3	6	**22**
SK	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	42	**47**
total revenues from transit gas	**244**	**115**	**85**	**26**	**615**	**38**	**3**	**101**	**212**	**90**	**26**	**19**	**102**	**24**	**502**	**4**	**4**	**0**	**189**	**353**	**59**	**140**	**0**	**12**	**500**	**3.462**

Assumption B: we consider the optimal gas flows and assume a set of contracts consistent with such flows.

In order to determine optimal gas flow patterns, we employ capacity, physical flows and tariff data from the dataset described in annex 1 and we develop an algorithm which:

A. Build the network structure given the physical capacities.
   - 25 suppliers: 5 extra-EU suppliers, 10 European production sites (considered as different self-standing countries connected to Member States), 10 entry points form LNG regassification premises (considered as different self-standing countries connected to Member States).
   - 27 countries: 26 EU Member States (Cyprus and Malta excluded) and Switzerland.
   - 116 borders: two countries are interconnected only when there is technical capacity between them. The model considers aggregated capacity at each border between two Member States (it aggregates technical capacity of all interconnection points connecting each couple of countries).

B. Associate each border to a tariff
   The model computes the average entry and exit capacity charge at each border between two countries (weighted-average calculated on the basis of capacity if there are more than one interconnection point). These charges will be employed as “entry border charges” and exit border charges”.

C. Given a supplier country Y and a MS A, find all «paths» going from Y to A.

D. Determine each path cost as the sum of the entry and exit border charges it employs.

E. Decision variables: physical flows along paths φ

F. Objective function: minimize the transport cost of the ϕ’s, imposing

G. Constraints:
   - φ may not exceed path capacity
   - Sum of φ’s exiting from each supplier must equal country export
   - Sum of φ’s exiting from each production sites must equal production
   - Sum of φ’s exiting from each LNG regassification sites must equal EU imports from LNG
   - Net flow in each MS must equal consumption

It should be noted that there are different sets of contract patterns that minimize transmission costs at EU level, and that each one of them corresponds to a different cost allocation among countries. For the purpose of this analysis, we have selected a plausible solution, while leaving to further research an investigation into the range of cost allocations among EU countries consistent with a given flow pattern.

However, the algorithm allows us to:

- identify a set of paths which minimise the transporting gas cost at European level.
  And allows us to understand how each Member State employ the EU transmission network under this assumption (see the following Table 13);
- split the “minimised” cost of transmission among Member States (see the following Table 14).

Once again, for the purpose of allocating the transmission cost of different flow patterns, we assume that capacity bookings match flows. This assumption is simplistic and brings us to underestimate actual costs of EU transmission.

The following tables show the output of our model.

Table 13. *Assumption B: Gas crossing transit countries to reach destination countries (TWh/y)*

Destination Country \ Transit Country	AT	BE	BG	CZ	DE	DK	EE	ES	FR	GB	GR	HR	HU	IE	IT	LT	LU	LV	NL	PL	PT	RO	SE	SI	SK	**total**
AT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	103	**103**
BE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	-	-	-	-	-	-	**66**
BG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34	-	-	-	**34**
CZ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	**100**
DE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	237	236	-	-	-	-	-	**473**
DK	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	**10**
EE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
ES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
FR	-	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	143	-	174	-	-	-	-	-	-	**398**
GB	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**20**
GR	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	**60**
HR	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	**20**
HU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
IE	-	-	-	-	-	-	-	-	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**31**
IT	438	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	438	**889**
LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	**2**
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
PL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58	-	-	-	-	-	**58**
PT	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**30**
RO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
SE	-	-	-	-	5	9	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	**15**
SI	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	**19**
SK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
total physical flow transiting	**447**	**81**	**30**	**0**	**13**	**9**	**0**	**30**	**0**	**51**	**0**	**0**	**20**	**0**	**0**	**0**	**143**	**0**	**478**	**298**	**0**	**64**	**0**	**13**	**650**	**2.328**

Table 14. *Assumption B: annual charges paid by destination countries to transit countries (mil.€).*

Transit Country

Destination Country	AT	BE	BG	CZ	DE	DK	EE	ES	FR	GB	GR	HR	HU	IE	IT	LT	LU	LV	NL	PL	PT	RO	SE	SI	SK	**total**
AT	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82	**91**
BE	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	**47**
BG	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	**28**
CZ	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74	**82**
DE	-	-	-	-	324	-	-	-	-	-	-	-	-	-	-	-	-	-	57	162	-	-	-	-	-	**542**
DK	-	-	-	-	6	5	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	**13**
EE	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**
ES	-	-	-	-	-	-	-	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**68**
FR	-	27	-	-	-	-	-	-	115	-	-	-	-	-	-	-	37	-	52	-	-	-	-	-	-	**231**
GB	-	-	-	-	-	-	-	-	-	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**77**
GR	-	-	23	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	9	-	-	-	**52**
HR	-	-	-	-	-	-	-	-	-	-	-	18	11	-	-	-	-	-	-	-	-	-	-	-	-	**29**
HU	-	-	-	-	-	-	-	-	-	-	-	-	62	-	-	-	-	-	-	-	-	-	-	-	-	**62**
IE	-	-	-	-	-	-	-	-	-	11	-	-	-	29	-	-	-	-	-	-	-	-	-	-	-	**40**
IT	268	-	-	-	-	-	-	-	-	-	-	-	-	-	286	-	-	-	-	-	-	-	-	7	350	**912**
LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	**1**
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	**1**
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	**0**
NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-	**22**
PL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	99	-	-	-	-	-	**99**
PT	-	-	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	**37**
RO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	**4**
SE	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	3	-	-	**11**
SI	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	8	**15**
SK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	**9**
total revenues from transit gas	**281**	**54**	**31**	**8**	**334**	**9**	**2**	**93**	**115**	**88**	**19**	**18**	**73**	**29**	**286**	**1**	**37**	**0**	**151**	**264**	**12**	**34**	**3**	**10**	**523**	**2.475**

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